

[0045] The invention has been described in detail with particular reference to certain preferred embodiments thereof, but it will be understood that variations and modifications can be effected within the spirit and scope of the invention.

PARTS LIST

[0046] 1, 2, 3, 4, 5 light rays
 [0047] 10 substrate
 [0048] 12 reflective electrode
 [0049] 14 organic layer(s)
 [0050] 16 transparent electrode
 [0051] 18 low-index gap
 [0052] 19 gap
 [0053] 20 encapsulating cover
 [0054] 22 scattering layer
 [0055] 24 OLED protection layer
 [0056] 30 thin-film electronic components
 [0057] 32 insulating planarization layer
 [0058] 34 insulating layer
 [0059] 40, 40R, 40G, 40B color filters
 [0060] 50, 52, 54, 56, 58 pixels
 [0061] 50R, 50G, 50B color sub-pixels
 [0062] 60 perimeter adhesive
 [0063] 70 light-scattering particles
 [0064] 71 light-scattering particles
 [0065] 74 adhesive binder
 [0066] 100 form OLED step
 [0067] 102 coat scattering layer step
 [0068] 14 dry coating step
 [0069] 106 align cover step
 [0070] 108 affix cover to substrate step

1. A top-emitting organic light-emitting diode (OLED) device, comprising:

a substrate;

an OLED comprising a reflective electrode formed on the substrate; one-or-more layers of organic light-emitting material formed over the reflective electrode; and a transparent electrode formed over the one-or-more layers of organic light-emitting material;

a light-scattering layer having a rough surface formed over and in contact with the OLED,

a cover affixed to the substrate forming a gap between the cover and the light scattering layer; and

wherein the gap is a vacuum or the gap is filled with a relatively low-refractive index gas and the light-scattering layer comprises a plurality of relatively high-refractive index light-scattering transparent particles projecting into the gap without contacting the cover and

further comprising an adhesive binder in contact with at least some of the light-scattering particles to adhere the light-scattering particles to the OLED.

2. The OLED device of claim 1, wherein the light-scattering layer comprises light-scattering particles having an average maximum dimension size between 400 nm and 5 microns.

3. The OLED device of claim 1, wherein the light-scattering layer comprises light-scattering particles having an average maximum dimension size between one micron and 2 microns.

4. The OLED device of claim 1, wherein the light-scattering layer comprises light-scattering particles having an average maximum dimension less than 2 microns.

5. The OLED device of claim 1, wherein the adhesive binder comprises less than 30% of the scattering layer by weight.

6. The OLED device of claim 1, wherein the adhesive binder comprises a polymer.

7. The OLED device of claim 6, wherein the polymer comprises polycarbonate, polyvinylcarbazole, or urethane.

8. The OLED device of claim 1, wherein the light-scattering particles comprise variably shaped particles.

9. The OLED device of claim 1, wherein the light-scattering particles comprise titanium dioxide.

10. The OLED device of claim 1, wherein the light-scattering layer has an average thickness between about one and five microns.

11. The OLED device of claim 1, further comprising an electrode protection layer formed between the transparent electrode and the light-scattering layer.

12. The OLED device of claim 1, wherein the gap is filled with a gas comprising nitrogen, argon, helium, or air.

13. A method of forming a top-emitting organic light-emitting diode (OLED) device, comprising the steps of:

forming an OLED over a substrate, the OLED comprising a reflective electrode formed on the substrate; one-or-more layers of organic light-emitting material formed over the reflective electrode; and a transparent electrode formed over the one-or-more layers of organic light-emitting material;

coating a dispersion comprising a solvent, relatively high-refractive index light-scattering transparent particles, and an adhesive binder over the OLED;

drying the coating to adhere the light-scattering particles to the OLED with the adhesive binder and form a light-scattering layer having a rough surface; and

affixing a cover to the substrate while forming a vacuum gap or a gap filled with a relatively low-refractive index gas between the cover and the light-scattering layer into which light-scattering particles project from the rough surface of the light-scattering layer without contacting the cover.

14. The method of claim 13, wherein the dispersion is coated over the OLED by spin coating, ink jet coating, spray coating, or hopper coating.

15. The method of claim 13, further comprising the step of providing a surfactant in the dispersion.